multichannel systems

32-Channel Miniature Preamplifier for FlexMEAs (MPA32I-FLEX) User Manual

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1 Important Information and Instruction

1.1 Operator's Obligations

The operator is obliged to allow only persons to work on the device, who

- are familiar with the safety at work and accident prevention regulations and have been instructed how to use the device;
- are professionally qualified or have specialist knowledge and training and have received instruction in the use of the device;
- have read and understood the chapter on safety and the warning instructions in this manual and confirmed this with their signature.

It must be monitored at regular intervals that the operating personnel are working safely.

Personnel still undergoing training may only work on the device under the supervision of an experienced person.

1.2 Guaranty and Liability

The *General conditions of sale and delivery* of Multi Channel Systems MCS GmbH always apply. The operator will receive these no later than on conclusion of the contract.

Multi Channel Systems MCS GmbH makes no guaranty as to the accuracy of any and all tests and data generated by the use of the device or the software. It is up to the user to use good laboratory practice to establish the validity of his findings.

Guaranty and liability claims in the event of injury or material damage are excluded when they are the result of one of the following.

- Improper use of the device
- Improper installation, commissioning, operation or maintenance of the device
- Operating the device when the safety and protective devices are defective and/or inoperable
- Non-observance of the instructions in the manual with regard to transport, storage, installation, commissioning, operation or maintenance of the device
- Unauthorized structural alterations to the device
- Unauthorized modifications to the system settings
- Inadequate monitoring of device components subject to wear
- Improperly executed and unauthorized repairs
- Unauthorized opening of the device or its components
- Catastrophic events due to the effect of foreign bodies or acts of God

1.3 Important Safety Advice

Warning: Make sure to read the following advices prior to install or to use the device and the software. If you do not fulfill all requirements stated below, this may lead to malfunctions or breakage of connected hardware, or even fatal injuries.

Warning: Obey always the rules of local regulations and laws. Only qualified personnel should be allowed to perform laboratory work. Work according to good laboratory practice to obtain best results and to minimize risks.

The product has been built to the state of the art and in accordance with recognized safety engineering rules. The device may only

- be used for its **intended purpose**;
- be used when in a **perfect condition**.
- Improper use could lead to serious, even fatal injuries to the user or third parties and damage to the device itself or other material damage.

Warning: The device and the software are **not** intended for medical uses and **must not** be used on humans.

- Malfunctions which could impair safety should be rectified immediately.
- Any physical damage of the cable, such as a broken cable, causes a physical damage of the miniature preamplifier that cannot be repaired.
- Protect the device from heat. Do not autoclave!
- You can clean the connectors with distilled water in an ultra sonic bath, but keep the cable away from the fluid. Dry the device with compressed air.
- Use and keep the device always in a dry environment. Do not expose it to fluids or vapor for a longer period of time.

2 Welcome to the MPA32I-FLEX

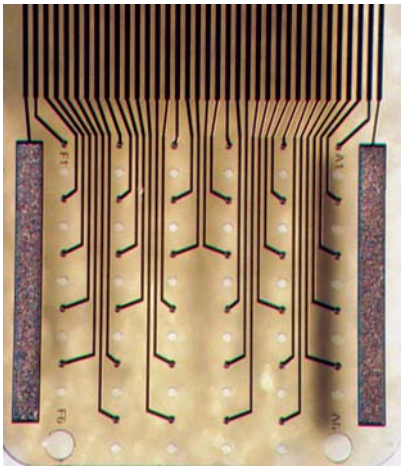
The 32-channel Miniature Preamplifier MPA32I is connected to the microelectrodes for providing the **initial tenfold amplification** stage.

It has additional **common ground** and **reference electrode inputs**. The reference electrode is ideally identical to the recording electrodes and placed into a comparable but inactive area or tissue. Background or noise signals that are picked up by both the reference electrode and the recording electrodes are removed.

The metal case provides **electrical shielding**. Electrode damage is prevented by the **very low bias current**. The **high input impedance** ensures **stable long-term recordings**: Ideally, the input impedance would be infinite. As low voltages are generally recorded, a high current would flow if the input impedance were low. As a result, the amplifier would not be able to deliver the current, and the voltage would break down. The miniature preamplifier has a high input impedance to avoid this problem.

The MPA32I-Flex is optimized for the use with flexible microelectrode arrays (FlexMEAs) from Multi Channel Systems. **FlexMEAs** are two-dimensional microelectrode arrays with **32 microelectrodes** for recording or stimulation, **2 indifferent reference electrodes**, and **2 large ground electrodes**. They are intended for recordings from several species, in both acute and long-term chronic experiments.

Please see the MEA User Manual for more details.



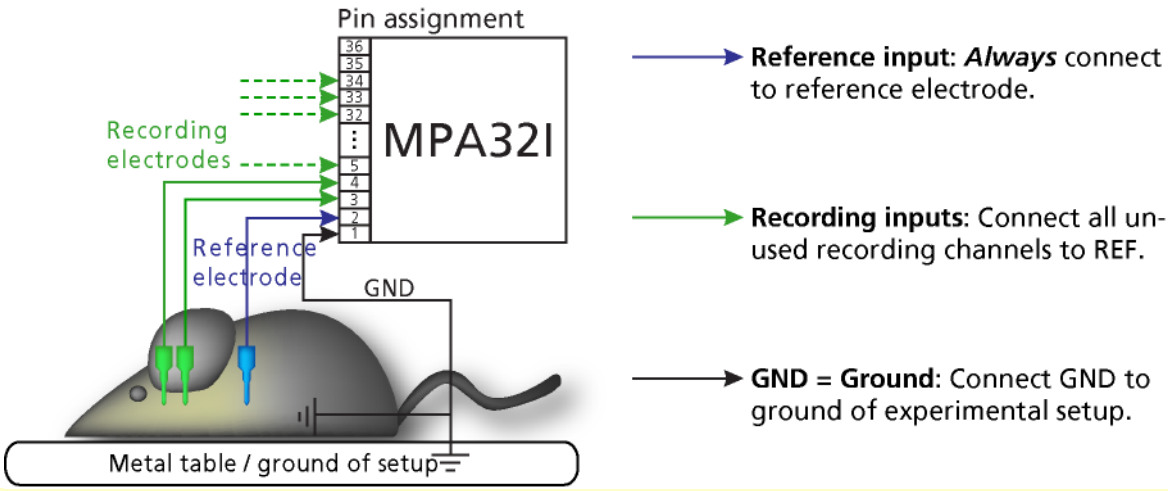
FlexMEA electrodes are **planar** with a diameter of only **30 µm** resulting in an impedance of about 50 kilohms, arranged in a square 6 x 6 grid, with an interelectrode distance of 300 µm. FlexMEAs are made of **flexible** and **biocompatible** polyimid as the base material supporting the titanium nitride (TiN) electrodes and the gold thin-film conductors. TiN allows the formation of electrodes as small as possible with an **excellent signal to noise ratio** and a **long lifetime**. Only 12 µm "thick" and weighing less than 1 g, the FlexMEA biosensor is very thin and lightweight. The flexible base is perforated for a better contact with the surrounding tissue.

3 Setting Up and Connecting the MPA

3.1 General Setup Recommendations

In the following, you find general recommendations for the installation.

Miniature preamplifier setup



Important: It is important that the **complete setup** refers to a **single common ground**. The **reference input** has **always** to be connected. It is recommended to use a **reference electrode**. However, if you are not using a reference electrode, connect the reference input to ground (GND). Otherwise, noise picked up by the reference input will be subtracted from the recording signals. **This will either lead to signal loss or to a very high noise level**.

1. Ground the animal with a **ground electrode** of **large surface area**, for example, a **liquid gel adhesive electrode**, that is connected to the **ground** of the setup, for example, a **large metal table** or a **Faraday cage**, to avoid pickup of noise from the environment. The ground electrode is best positioned in an electrically inactive region (not near muscle, nor heart), for example, at the **belly**.

2. Connect the **GND input** or the **metal case** of the miniature preamplifier to the **common ground** of the **setup**. (The GND input is internally connected to the metal case.)

3. Connect the **reference electrode** to **the reference input** of the miniature preamplifier. Generally, a reference electrode is inserted into non-active tissue of the experimental model. The reference electrode should be identical to the recording electrode so that both electrodes see the same background noise. This is necessary because despite the grounding, the animal's body often has not exactly a potential of zero, due to the electrode impedance, for example. The background noise is then subtracted from the recording signal, increasing the signal to noise ratio. Please note that this may not work if the complete setup is not properly grounded.

4. (Optional) If two reference electrodes are used, connect the second electrode to the free reference input. Otherwise, leave it free. It is generally not necessary to use a second reference electrode. It can be used to enlarge the surface area of the reference, though.

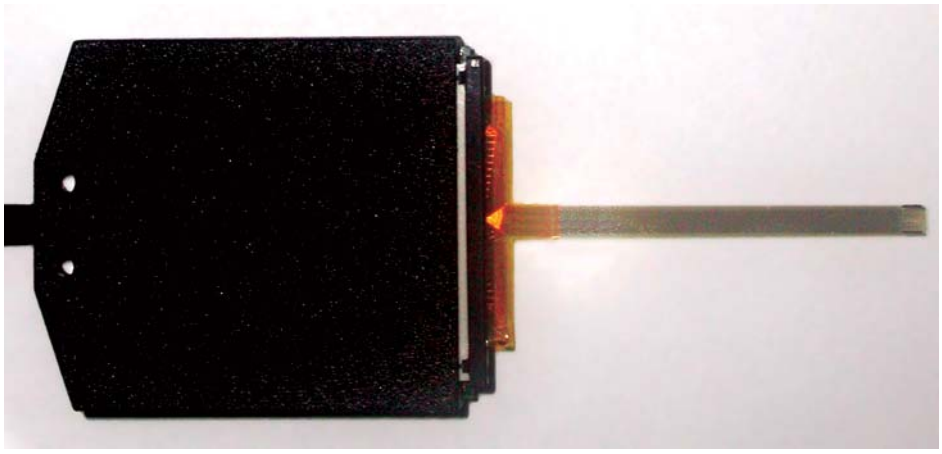
5. Connect the **recording electrodes** to the **recording channels** of the miniature preamplifier. You can either use single electrodes or multitrodes with the miniature preamplifier. MCS provides adapters for standard probes.

6. Connect **all unused recording channels** to the **REF input** or to the **reference electrode** (or to the amplifier's ground if that is not possible) to avoid noise pickup. As the total amplifier gain generally lies in the range of 1000, even very small noise signals may generate high noise signals.

7. If you are not using a Faraday cage, it might be necessary to **shield** the complete setup with aluminum foil or similar to prevent electrical interference from the outside. Connect the aluminum foil to the ground of the setup (for example, the metal table).

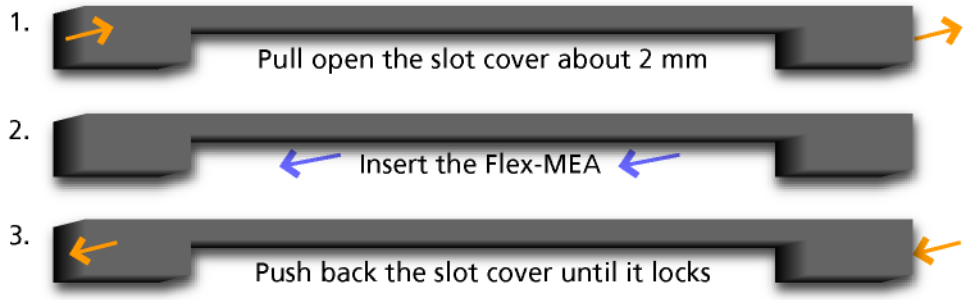
Troubleshooting: If you observe problems with noise, check that the ground of the **setup** is connected to exactly the **same ground** as the **data acquisition computer**. For example, connect the metal table to the ground/earth wire of a free power outlet (of the same electrical system), as the computer is generally connected to ground/earth via the power plug, too. Also, connect the **data acquisition computer's metal case** with a **thick ground wire** to the **ground** of the **setup** (for example, the metal table), preferably with a 4 mm plug.

3.2 Connecting FlexMEAs



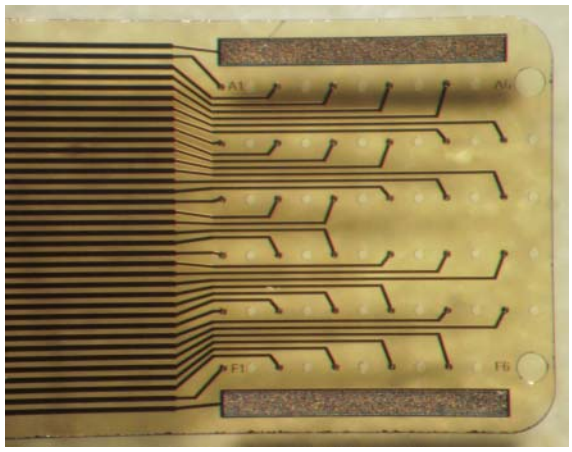
The MPA32I-FLEX has a slot for inserting FlexMEAs. For a tight and reliable connection, the FlexMEA contacts are pressed down onto the amplifier contacts by the slot lid. To insert the MEA, you have to pull open the slot lid.

Inserting the Flex-MEA into the MPA32I-FLEX slot



1. Grip the sides of the black with your fingers and carefully pull open the slot cover only a little bit (about 1 or 2 mm). Do not demount the cover as the plastic supports might break easily.
2. Insert the FlexMEA into the slot, with the contact pads upside down.
3. Carefully push back the slot cover until it locks.

3.3 FlexMEAs



FlexMEAs are made of flexible polyimid material, perfect for *in vivo* and special *in vitro* applications. Only 12 µm "thick" and weighing less than 1 g, the FlexMEA biosensor is very thin and lightweight.

FlexMEAs have 32 electrodes plus two indifferential reference electrodes and two ground electrodes. More layouts can be provided on request. The flexible base is perforated for a better contact with the surrounding tissue.

The electrodes have a diameter of about 30 µm with an interelectrode distance of 300 µm.

Conducting material is pure gold.

Using FlexMEAs

FlexMEAs are usually connected to a headstage preamplifier that is connected to a filter amplifier or programmable gain amplifier (see also the ME System product line of Multi Channel Systems). FlexMEAs can be directly connected to a 32-channel miniature preamplifier from Multi Channel Systems for *in vivo* experiments. FlexMEAs are stable at a temperature range from 10 °C to 40 °C.

Warning: Do **not** autoclave or sterilize **FlexMEAs** by **heat**. These MEA types are not heat-stable and will be irreversibly damaged if the temperature is too high.

4 Service and Maintenance

4.1 Cleaning the Connectors

Warning: Make sure that only the connectors touch the liquid; do not submerge the miniature preamplifier or the cable into cleaning solutions. Otherwise, you can fatally damage the electronics. It is recommended to avoid the use of aqueous cleaning solutions to avoid corrosion. If necessary, use distilled water.

→ Clean the connectors with 70 % alcohol and cotton swabs from time to time.

→ If this does not provide satisfying results, insert only the connectors into a small beaker with acetone or alcohol and sonificate for 10–20 s in an ultrasonic bath. Air-dry the miniature preamplifier for about 5 min before use.

→ You can clean the connectors with distilled water in an ultra sonic bath. Dry the connectors with compressed air immediately after sonification and let the amplifier air dry for at least 6 h before use.

4.2 Sterilization

Warning: Do **not** autoclave or sterilize miniature preamplifiers by high **heat (above 70 °C) or vapor**. The resin is not heat-stable and may deform under heat. Vapor can lead to a corrosion of the electronics.

Miniature preamplifiers can be sterilized with standard methods that are **not** based on high heat or vapor, for example, with 70 % ethanol, UV-light, or by thermal sterilization in an oven at 56 °C with an incubation time of 8 hours.

5 Pin Layout

5.1 Power Supply

Supply voltage is applied to the output connector pins 19 and 37. The voltage source should supply a stable noise-free voltage. Do not exceed the maximum voltage.

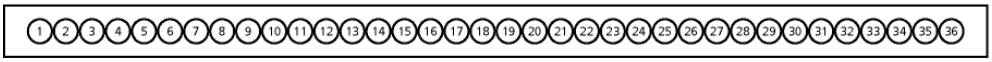
Pin 19: –3 V to –8 V

Pin 37: +3 V to +8 V

Warning: Do not mismatch the polarity of the power supply. A false connection may damage the unit.

5.2 Inputs

32-Channel Miniature Preamplifier for Flex-MEAs inputs



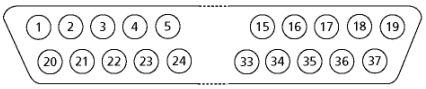
Pin 1: GND (ground)
Pin 2: Reference
Pin 3-34: Channel 1-32
Pin 35: Reference
Pin 36: GND (ground)

This illustration shows the pin layout viewed from the front, with the case screws upside down.

The two reference inputs are used for connecting a reference electrode. Both inputs are equal, so it does not matter which of the two inputs is used. If both are used, the mean of both reference signals is used as reference.

5.3 Outputs

32-Channel Miniature Preamplifier outputs



Pin 1:	GNDP (power ground)	Pin 29:	Channel 18
Pin 20:	GNDS (signal ground)	Pin 11:	Channel 19
Pin 2:	Channel 1	Pin 30:	Channel 20
Pin 21:	Channel 2	Pin 12:	Channel 21
Pin 3:	Channel 3	Pin 31:	Channel 22
Pin 22:	Channel 4	Pin 13:	Channel 23
Pin 4:	Channel 5	Pin 32:	Channel 24
Pin 23:	Channel 6	Pin 14:	Channel 25
Pin 5:	Channel 7	Pin 33:	Channel 26
Pin 24:	Channel 8	Pin 15:	Channel 27
Pin 6:	Channel 9	Pin 34:	Channel 28
Pin 25:	Channel 10	Pin 16:	Channel 29
Pin 7:	Channel 11	Pin 35:	Channel 30
Pin 26:	Channel 12	Pin 17:	Channel 31
Pin 8:	Channel 13	Pin 36:	Channel 32
Pin 27:	Channel 14	Pin 18:	GNDP (power ground)
Pin 9:	Channel 15	Pin 37:	Positive supply voltage
Pin 28:	Channel 16	Pin 19:	Negative supply voltage
Pin 10:	Channel 17		

Connected to the ground of the amplifier. The signal ground is used as the reference for the following filter amplifier.

6 Contact Information

Local retailer

Please see the list of official MCS distributors on the MCS web site.

User forum

The **Multi Channel Systems User Forum** provides an excellent opportunity for you to exchange your experience or thoughts with other users worldwide.

Mailing list

If you have subscribed to the ME-System mailing list, you will be automatically informed about new software releases, upcoming events, and other news on the product line. You can subscribe to the list on the MCS web site.

www.multichannelsystems.com

7 Ordering Information

Please contact your local retailer for pricing and ordering information.

7.1 ME Systems

Product	Product Number	Description
Data acquisition system with 16 analog channels	ME16 System	Complete with data acquisition computer with MC_Card and IPS10W, and software package
Data acquisition system with 32 analog channels	ME32 System	
Data acquisition system with 64 analog channels	ME64 System	
Data acquisition system with 128 analog channels	ME128 System	

7.2 Amplifiers

Product	Product Number	Description
Miniature preamplifier with 2 electrode inputs	MPA2I	Small sized and light weight headstage with common ground and additional indifferent reference electrode input, input type I, gain = 10
Miniature preamplifier with 8 electrode inputs	MPA8I	
Miniature preamplifier with 32 electrode inputs	MPA32I	
Miniature preamplifier with 32 electrode inputs for use with FlexMEAs	MPA32IFLEX	
Filter amplifiers with 4, 8, 16, 32, 48, or 64 channels and input type S or I	FA*NNX*	*NN* is the total number of channels, *X* is the input type (S or I), with custom gain and bandwidth
Amplifier with programmable gain, 16 channels	PGA16	Gain programmable from 10 to 5000, with custom bandwidth
Amplifier with programmable gain, 32 channels	PGA32	
Amplifier with programmable gain, 64 channels	PGA64	
Amplifier with programmable gain, 16 input and 32 output channels	PGA1632	Gain programmable from 10 to 5000, with two different custom pass bands
Amplifier with programmable gain, 32 input and 64 output channels	PGA3264	

7.3 Accessories

Product	Product Number	Description
Signal collector for 2 x MPA32I	SC2x32	Collects the channels from each of the up to 2 miniature preamplifiers MPA32I and leads them to the amplifier via a 68-pin MCS standard cable
Power supply with 20 W power and +/– 7 V output voltage	PS20W	For supplying power to programmable gain amplifiers, for custom setups that lack an internal power supply, or for other custom applications

7.4 FlexMEAs

Product	Product Number	Description
Flexible microelectrode array (FlexMEA)	FlexMEA	With 36 electrodes in total: 32 electrodes arranged in a 6 x 6 grid + 2 reference electrodes + 2 ground electrodes. 30 µm electrode diameter, 300 µm interelectrode distance. TiN electrodes and gold tracks embedded in flexible polyimid.

MPA Miniature Preamplifier

multichannel systems

	MPA2I	MPA8I	MPA32I	MPA32IFLEX
Operating temperature	0 °C to 50 °C	0 °C to 50 °C	0 °C to 50 °C	0 °C to 50 °C
Storage temperature	0 °C to 50 °C	0 °C to 50 °C	0 °C to 50 °C	0 °C to 50 °C
Relative humidity	10 % to 85 %, non-condensing	10 % to 85 %, non-condensing	10 % to 85 %, non-condensing	10 % to 85 %, non-condensing
Dimensions (W x D x H)	12 mm x 31 mm x 3 mm	17 mm x 25 mm x 1.8 mm	27 mm x 36 mm x 5 mm	27 mm x 34 mm x 5 mm
Weight		1.3 g w/o cable and plug, 21 g with cable and plug	7 g w/o cable and plug, 56 g with cable and plug	7 g w/o cable and plug, 56 g with cable and plug
Maximum tensile strength of cable	2 kg	2 kg	2 kg	2 kg
Input connector type	Single-row precision sockets, 50 mil (1.27 mm) grid pattern, for 0.35-0.45 mm round pins)	Single-row precision sockets, 50 mil (1.27 mm) grid pattern, for 0.35-0.45 mm round pins)	Dual-row precision sockets, 50 mil (1.27 mm) grid pattern, for 0.35-0.45 mm round pins)	Special input for use with FlexMEAs
Supply voltage	± 3 V to ± 8 V DC	± 3 V to ± 8 V DC	± 3 V to ± 8 V DC	± 3 V to ± 8 V DC
Supply current	< ± 2 mA, typically ± 1 mA	< ± 6 mA, typically ± 4 mA	< ± 14 mA, typically ± 9 mA	< ± 14 mA, typically ± 9 mA
Number of input channels	2	8	32	32
Input voltage	0 to 500 mV (with respect to a supply voltage of 5 V)	0 to 500 mV (with respect to a supply voltage of 5 V)	0 to 500 mV (with respect to a supply voltage of 5 V)	0 to 500 mV (with respect to a supply voltage of 5 V)
Input impedance	10^{12} Ω parallel to 10 pF	10^{12} Ω parallel to 10 pF	10^{12} Ω parallel to 10 pF	10^{12} Ω parallel to 10 pF
Input noise	< 1.5 μV_{RMS} (1 Hz to 5 kHz, inputs short-circuited)	< 1.5 μV_{RMS} (1 Hz to 5 kHz, inputs short-circuited)	< 1.5 μV_{RMS} (1 Hz to 5 kHz, inputs short-circuited)	< 1.5 μV_{RMS} (1 Hz to 5 kHz, inputs short-circuited)
Noise density	$e_n = 15 \ nV/\sqrt{Hz}$	$e_n = 15 \ nV/\sqrt{Hz}$	$e_n = 15 \ nV/\sqrt{Hz}$	$e_n = 15 \ nV/\sqrt{Hz}$
Number of output channels	2	8	32	32
Output voltage	= supply voltage	= supply voltage	= supply voltage	= supply voltage
Output current	max ± 10 mA	max ± 10 mA	max ± 10 mA	max ± 10 mA
Output impedance	0 Ω	0 Ω	0 Ω	0 Ω
Bandwidth	DC to 50 kHz	DC to 50 kHz	DC to 50 kHz	DC to 50 kHz
Gain	10	10	10	10

Versions with 2, 8 and 32 channels available, MPA2I, MPA8I, and MPA32I, respectively. MPA 32IFLEX is a special version for use with Flex-MEAs.

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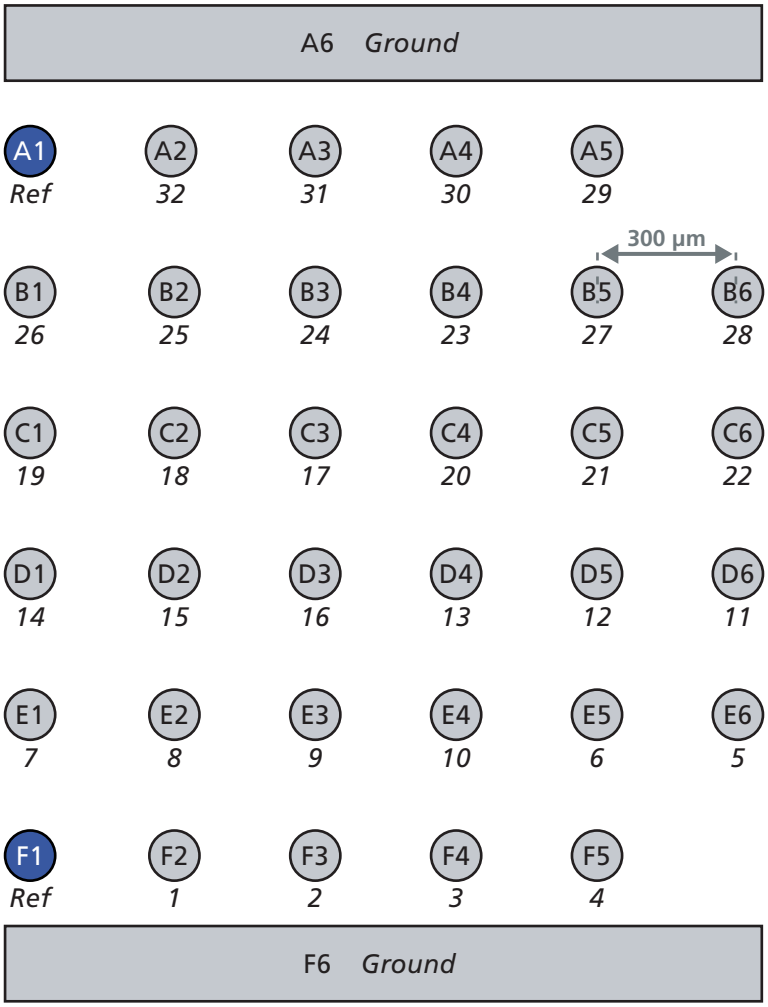
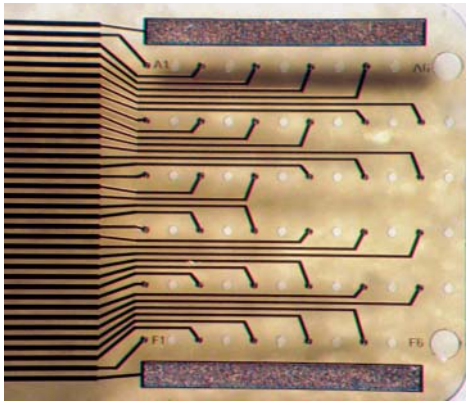
FlexMEA

multichannel systems

36 Electrodes: 32 recording electrodes, 2 indifferent reference electrodes, 2 large ground electrodes; for use with miniature preamplifier MPA32I-FLEX





The letter-digit code is the electrode identifier and refers to the position of the electrode in the grid. Below are the recording channel numbers (in italics) that refer to the channel numbers in the MC_Rack program. Please make sure that you have selected the linear channel layout in the MC_Rack program. See the MC_Rack user manual or help for details.
If you use more than one MPA32I-FLEX and a ME64 System, the signal collector SC2x32 leads the output channels of the second amplifier to channel number 33-64. Please see the SC2x32 data sheet for details.

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